LAW OFFICES
SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
WASHINGTON, DC 20037-3213
TELEPHONE (202) 293-7060
FACSIMILE (202) 293-7860

November 22, 1999

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Yasuyoshi YAMADA
BACK ELECTRODE TYPE ELECTRONIC
PART AND ELECTRONIC ASSEMBLY
WITH THE SAME MOUNTED ON PRINTED CIRCUIT BOARD
Our Ref. Q56857

Dear Sir:

Attached hereto is the application identified above including 19 sheets of the specification, claims, 4 sheets of drawings, executed Assignment and PTO 1595 form, and executed Declaration and Power of Attorney. Also enclosed is the Information Disclosure Statement with form PTO-1449 and references.

The Government filing fee is calculated as follows:

Total claims	12	-	20	=		x	$18.00	= $.00
Independent claims	2	-	3	=		x	$78.00	= $.00
Base Fee								$760.00
TOTAL FILING FEE								**$760.00**
Recordation of Assignment								$40.00
TOTAL FEE								**$800.00**

Checks for the statutory filing fee of $760.00 and Assignment recordation fee of $40.00 are attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16 and 1.17 and any petitions for extension of time under 37 C.F.R. § 1.136 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from December 4, 1998 based on Japanese Application No. 346025/1998. The priority document is enclosed herewith.

Respectfully submitted,
SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
Attorneys for Applicant

By: _____
J. Frank Osha
Registration No. 24, 625

BACK ELECTRODE TYPE ELECTRONIC PART AND ELECTRONIC ASSEMBLY WITH THE SAME MOUNTED ON PRINTED CIRCUIT BOARD

Background of the Invention

1. Field of the Invention

The present invention relates to a back electrode type electronic part and an electronic assembly with the same mounted on a printed circuit board.

2. Description of the Related Art

With appearance of a small size electronic appliance such as a portable information terminal, a back electrode type or a Ball Grid Array (BGA) type electronic part used in such an electronic appliance is made small in size. Also, a BGA electrode is made small. Therefore, a soldering connection section between the BGA type electronic part and a printed circuit board in the electronic appliance is made small so that the endurance to heat cycle stress and external stress is decreased.

Fig. 1 shows a cross sectional view of an electronic assembly with a printed circuit board on which a conventional BGA type electronic part is mounted. Referring to Fig. 1, solder balls 13 are provided between electrode lands 12 of the

electronic part 11 and electrode lands 16 of the printed circuit board 15. Especially, the solder balls on the corners are shown by a reference numerals 14.

In Japanese Laid Open Patent Application (JP-A-Heisei 10-56093), a semiconductor device and an electric appliance in which the semiconductor device is incorporated are described. In this reference, a dummy electrode is provided in a corner section of a BGA electrode arrangement while one substrate electrode corresponds to one part electrode. Thus, even if a crack is generated in a solder connection section of the dummy electrode due to heat cycles, solder connection of a signal electrode is guaranteed.

and even if

A heat cycle stress is applied to the printed circuit board on which the BGA type electronic part is mounted, due to environment temperature change and change of the heating of BGA type electronic part itself. At this time, any warp is caused for the difference in thermal expansion percentage between the BGA type electronic part and the printed circuit board. This warp often centers on the solder connection sections in 4 peripheral corner sections of

electrode arrangement of the BGA type electronic part. When the solder connection section is not endured for this warp, there is the high possibility that the crack is generated in the solder connection section.

Also, when an external stress is applied to the printed circuit board on which the BGA type electronic part is mounted, to bend the board, the 4 corner sections of the electrode arrangement of the BGA type electronic part are easiest to receive stress transformation most. This is because there are few neighbor electrodes by which the stress can be dispersed and the transformation of the printed circuit board due to the external stress becomes the largest. The destruction of the solder connection section through the stress transformation often progresses from the 4 corner sections toward the inside of the electrode arrangement.

In conjunction with the above description, a chip carrier is disclosed in Japanese Laid Open Patent Disclosure (JP-A-Heisei 4-314355). In this reference, positioning pads are provided on a back surface of a chip carrier to have a larger area than connection pads. A conductive circuit is provided on a substrate to have a larger area than a connection conductive circuit

corresponding to the connection pad. The chip carrier is preliminarily soldered and the chip carrier is positioned on the substrate. Then, reflow is carried out. Thus, the positioning is carried out by use of solder balls for the positioning pads and then the connection pads are connected to the substrate.

Also, a semiconductor device is disclosed in Japanese Laid Open Patent Disclosure (JP-A-Heisei 9-330993). In this reference, a solder bump forming land 3 is separately formed as lands 3a and 3b in a BGA structure. After the semiconductor chip 1 is molded, a test is carried out by use of the lands 3a and 3b. Thereafter, when a solder bump is formed, lands 3a and 3b are electrically connected by a single solder bump.

Also, a BGA semiconductor device is disclosed in Japanese Laid Open Patent Disclosure (JP-A-Heisei 7-321247). In this reference, a pad 14 is formed to have a shape in which a length in a direction of a line passing through a transformation center 12 is larger than that in a direction orthogonal to the line. Thus, a contact angle in a direction of generation of thermal warp is made larger than a conventional device so that a solder life to the thermal warp is elongated.

Also, a surface mounting type semiconductor package is disclosed in Japanese Laid Open Patent Disclosure (JP-A-Heisei 9-307022). In this reference, a semiconductor package 3 has a rectangular package body 15. Solder balls 22 which are covered by a solder layer 23 are arranged in a matrix on a back surface 16b of the package body. The solder balls are soldered to pads 8 of a printed circuit board 2 by reflow. The solder balls 22a in the outermost of an arrangement area of the solder balls have a larger diameter than the other solder balls.

In addition, a BGA electronic part is disclosed in Japanese Registered Utility Model No. 3012948. In this reference, dummy terminals 8 are provided in a region of soldering sections where any crack is easy to be generated due to heat cycles. The dummy terminals are arranged in an outermost portion or corner portions of the terminal arrangement.

Summary of the Invention

Therefore, an object of the present invention is a back electrode type electronic part in which strength of the solder connection sections at the 4 corner sections of the electrode arrangement is increased for

improvement of the mount reliability.

Another object of the present invention is to provide an electronic assembly in which such a back electrode type electronic part is mounted on a printed circuit board by which the reliability of the assembly is increased.

In order to achieve an aspect of the present invention, a back electrode type electronic part includes a main body including a circuit, and electrodes arranged for solder bumps on a back surface portion of the electronic part and connected to the circuit. Each of groups of the electrodes in portions of the electrode arrangement is provided for a single first solder bump which is larger than second solder bumps for the electrodes arranged other than the corner portions. Also, the group of electrodes includes electrodes having a substantially same potential level when the circuit operates.

The electrodes may be arranged in a matrix, and the corner portions may be 4 corner portions.

Also, the group of electrodes may include a non-contact electrode which is not connected to the circuit.

Also, one of the electrodes of the group may be a signal electrode, a ground potential electrode, or a power supply potential electrode.

In order to another aspect of the present invention, an electronic assembly includes a back electrode type electronic part, a printed circuit board and solder bumps. The back electrode type electronic part includes electrodes provided on a back surface portion of the electronic part and connected to the circuit. Groups of the electrodes at corner portions of the electrode arrangement is groups of integrated electrodes, and the group of integrated electrodes includes the electrodes having a substantially same potential level when the circuit operates. The printed circuit board has substrate electrodes corresponding to the electrodes provided for the electronic part. One of the substrate electrodes as a first substrate electrode is provided for each of the groups of integrated electrodes, and the substrate electrodes as second substrate electrodes other than the first substrate electrodes are provided for the electrodes of the electronic part other than the integrated electrodes. Solder bumps including first solder bumps connected with the groups of integrated electrodes and the first substrate electrodes and second solder bumps connected with the second substrate electrodes and the electrodes of the electronic part other than the integrated

electrodes.

Also, the electrodes of the electronic part may be arranged in a matrix, and the portions are 4 corner portions.

Also, one of the integrated electrodes of the group may be a non-contact electrode which is not connected to the circuit, a signal electrode or a power supply potential electrode.

Brief Description of the Drawings

Fig. 1 is a cross sectional view showing the state in which a conventional BGA type electronic part is mounted on a printed circuit board;

Fig. 2 is a back plan view showing the electrode arrangement of a BGA type electronic part according to a fist embodiment of the present invention;

Fig. 3 is a partial plan view showing the electrode arrangement of a printed circuit board on which the BGA type electronic part of Fig. 2 is mounted;

Fig. 4 is a plan view showing the state in which the BGA type electronic part of Fig. 2 is mounted on the printed circuit board of Fig. 3;

Fig. 5 is a cross sectional view along the line A-A of Fig. 4 when the BGA type electronic

part of Fig. 2 is mounted on the printed circuit board of Fig. 3;

Fig. 6 is a plan view showing the electrode arrangement of the BGA type electronic part according to a second embodiment of the present invention; and

Fig. 7 is a plan view showing the state in which the BGA type electronic part of Fig. 6 is mounted on the printed circuit board.

Description of the Preferred Embodiments

Hereinafter, a back electrode type electronic part and an assembly in which the back electrode type electronic part is mounted on a printed circuit board will be described

Fig. 2 is a back plan view showing a back electrode type or BGA type electronic part according to the first embodiment of the present invention. A reference numeral 1 in Fig. 2 denotes the BGA type electronic part, 2 denotes integration possible specific electrodes, and 3 denotes a general electrodes. The electronic part includes a circuit (not shown) therein and the specific electrodes 2 and the general electrodes 3 are connected to the circuit. In the first embodiment, a set of four ground potential electrodes as the specific electrodes 2 are

provided at each of four corner sections of the BGA type electronic part 1. As seen from Fig. 2, the electrodes are arranged in a matrix with a constant distance between adjacent ones in a row direction or a column direction. However, a pitch between the specific electrodes may be shorter than a pitch between the general electrodes. Also, in Fig. 3, all the electrodes have the same size. However, the specific electrode may be have a different from the general electrode in size. For example, the specific electrode may be larger or smaller than the general electrode.

Although ground potential electrodes are used as the specific electrodes, other electrode may be used as the specific electrodes. For example, the following electrodes shown by ① to ⑦ may be used as a set of integration possible electrodes. That is,

① the ground potential electrodes are gathered or are provided newly for a set;

② non-contact electrodes which are not connected to the circuit of the electronic part 1 are gathered or are provided newly for a set;

③ signal electrodes which having a same signal level when the circuit operates are gathered or are provided newly for a set;

④ power supply potential electrodes are

gathered or are provided newly for a set;

⑤ ground potential electrodes and non-contact electrode electrodes are gathered for a set;

⑥ same signal electrodes and non-contact electrode electrodes are gathered for a set; and

⑦ power supply electrodes and non-contact power supply electrodes are gathered for a set.

Fig. 3 shows a printed circuit board on which the BGA type electronic part 1 shown in Fig. 2 is mounted. In Fig. 3, a reference numeral 4 denotes a substrate, 5 denotes an integration electrode and 6 denotes a general electrode. The substrate 4 in this embodiment has an integration electrode 5 for the specific electrodes 2 in the BGA type electronic part shown in Fig. 2 and a general electrode 6 for the general electrode 3. The integration electrodes are provided at the four corner sections and the four specific electrode are integrated into the same integration electrode 5. By this, the solder connection section is made large so that it is made possible to improve the connection strength between the soldered BGA type electronic part and the printed circuit board.

Fig. 4 shows the state in which the BGA type electronic part shown in Fig. 1 is soldered to the printed circuit board 4 shown in Fig. 3.

The group of specific electrodes 2 of the BGA type electronic part 1 are soldered to the integration electrode 5 of the printed circuit board 4. At this time, as shown in Fig. 5, a solder bump for the specific electrodes 2 of the BGA type electronic part and the integration electrode 5 is large. The solder bump for the general electrode 3 of the BGA type electronic part and the general electrode 6 of the printed circuit board 4 is small.

That is, the large solder connection section between the specific electrodes 2 of the BGA type electronic part and the integration electrode 5 of the printed circuit board 4. As a result, the connection strength of the solder connection sections in the four corner sections is improves increasingly. Therefore, it becomes possible to prevent generation of any crack due to the above-mentioned heat cycle stress and destruction due to the external stress, resulting in improvement of the reliability of the mounted BGA type electronic part.

In the present invention, the number of specific electrodes gathered at each of the four corner sections is not limited to 4 electrodes, and may be an optional number. For example, as shown in Fig. 6, three specific electrodes 3,

namely, the specific electrode 2 situated in each of the four corner of the BGA type electronic part 1 and the two electrodes 2 arranged along the edge section of the BGA type electronic part 1 and located in the neighborhood to the above electrode 2 are set as the integration possible specific electrodes. Also, the number of integration electrodes is not limited to four. The number of integration electrodes may be an optional number.

Also, as shown in Fig. 7, a square integration electrode 10 is provided for the substrate 4 to mount the BGA type electronic part 1 shown in Fig. 6. This integration electrode 10 is connected with three specific electrodes 2 of the BGA type electronic part 1 shown in Fig. 6 with solder.

The integration electrode provided on the substrate 4 may be circular as shown in Fig. 3 and Fig. 4, rectangular as shown in Fig. 7, or optional shapes such as an ellipse and an oval shape.

According to the present invention, the group of specific electrodes is soldered to the integration electrode of the substrate while the general electrode of the BGA type electronic part is connected with the general electrode of the

printed circuit board. The solder connection section of the specific electrodes of the BGA type electronic part is made large in each of the four corner sections. Therefore, the connection strength of the soldering section in the four corners is increased. Also, it is possible to prevent generation of the crack due to the above-mentioned heat cycle stress and the destruction due to the external stress, resulting in the improvement of the loaded reliability of the BGA type electronic part.

What is claimed is:

1. A back electrode type electronic part comprising:

a main body including a circuit; and

electrodes arranged for solder bumps on a back surface portion of said electronic part and connected to said circuit, and

wherein each of groups of said electrodes at portions of the electrode arrangement is provided for a single first solder bump which is larger than second solder bumps for said electrodes arranged other than said corner portions, and

wherein said group of electrodes includes electrodes having a substantially same potential level when said circuit operates.

2. A back electrode type electronic part according to claim 1, wherein said electrodes are arranged in a matrix, and said portions are 4 corner portions.

3. A back electrode type electronic part according to claim 1, wherein said group of electrodes includes a non-contact electrode which is not connected to said circuit.

4. A back electrode type electronic part according to claim 1, wherein one of said electrodes of said

group is a signal electrode.

5. A back electrode type electronic part according to claim 1, wherein one of said electrodes of said group is a ground potential electrode.

6. A back electrode type electronic part according to claim 1, wherein one of said electrodes of said group is a power supply potential electrode.

7. An electronic assembly comprising:

a back electrode type electronic part comprising:

a main body including a circuit, and

electrodes provided on a back surface portion of said electronic part and connected to said circuit, wherein groups of said electrodes at portions of the electrode arrangement is groups of integrated electrodes, and wherein said group of integrated electrodes includes said electrodes having a substantially same potential level when said circuit operates;

a printed circuit board having substrate electrodes corresponding to said electrodes provided for said electronic part, wherein one of said substrate electrodes as a first substrate electrode is provided for each of said groups of integrated

electrodes, and said substrate electrodes as second substrate electrodes other than said first substrate electrodes are provided for said electrodes of said electronic part other than said integrated electrodes; and

solder bumps including first solder bumps connected with said groups of integrated electrodes and said first substrate electrodes and second solder bumps connected with said second substrate electrodes and said electrodes of said electronic part other than said integrated electrodes.

8. A back electrode type electronic part according to claim 7, wherein said electrodes of said electronic part are arranged in a matrix, and said portions are 4 corner portions.

9. A back electrode type electronic part according to claim 7, wherein one of said integrated electrodes of said group is a non-contact electrode which is not connected to said circuit.

10. A back electrode type electronic part according to claim 7, wherein one of said integrated electrodes of said group is a signal electrode.

11. A back electrode type electronic part according

to claim 7, wherein one of said electrodes of said group is a ground potential electrode.

12. A back electrode type electronic part according to claim 7, wherein one of said electrodes of said group is a power supply potential electrode.

Abstract of the Disclosure

A back electrode type electronic part includes a main body including a circuit, and electrodes arranged for solder bumps on a back surface portion of the electronic part and connected to the circuit. Each of groups of the electrodes in portions of the electrode arrangement is provided for a single first solder bump which is larger than second solder bumps for the electrodes arranged other than the corner portions. Also, the group of electrodes includes electrodes having a substantially same potential level when the circuit operates.

Fig. 1PRIOR ART

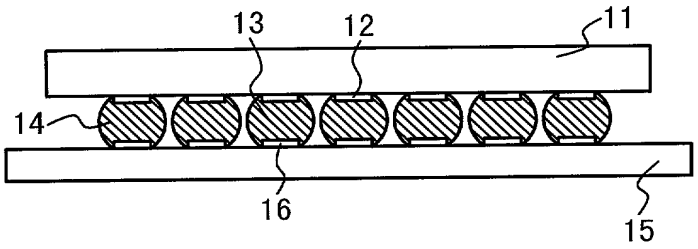


Fig. 2

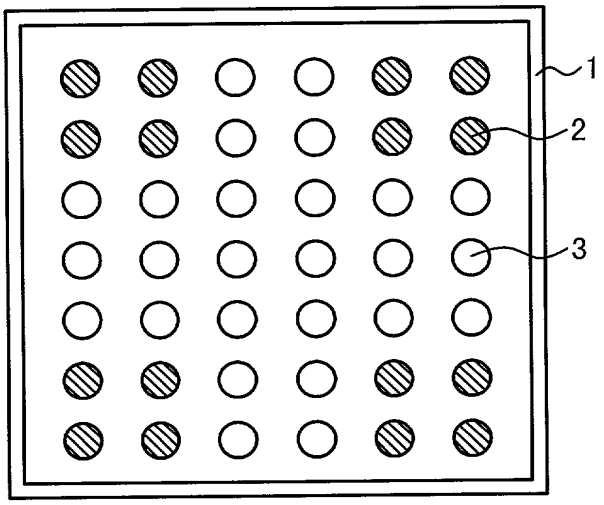


Fig. 3

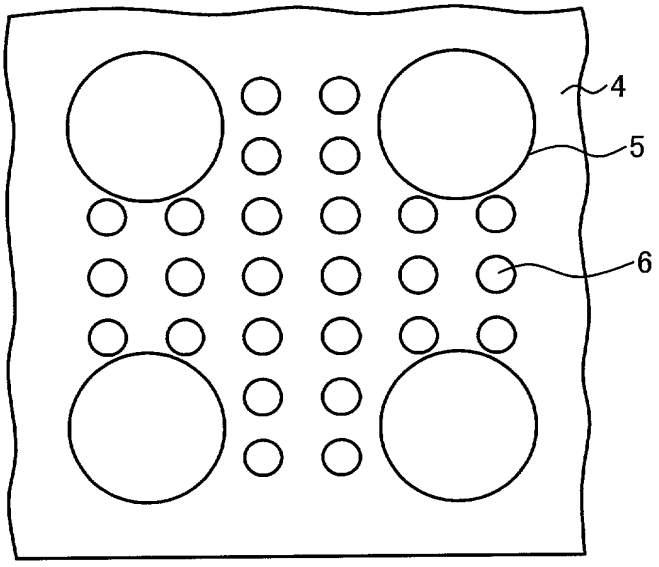


Fig. 4

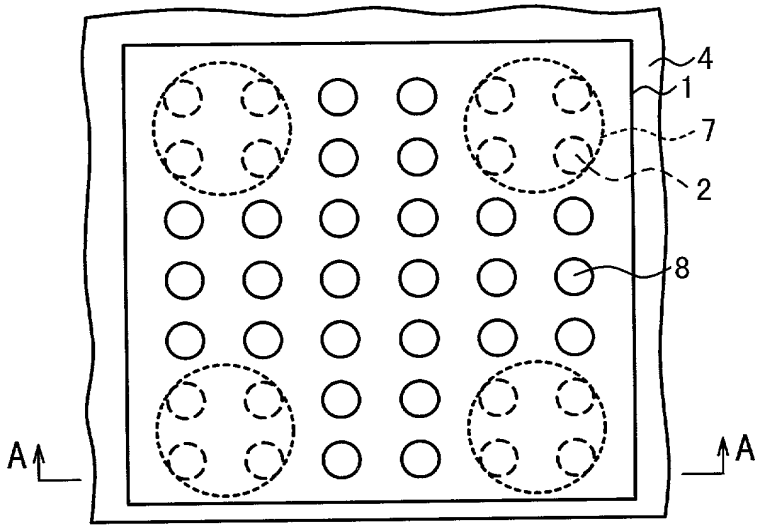


Fig. 5

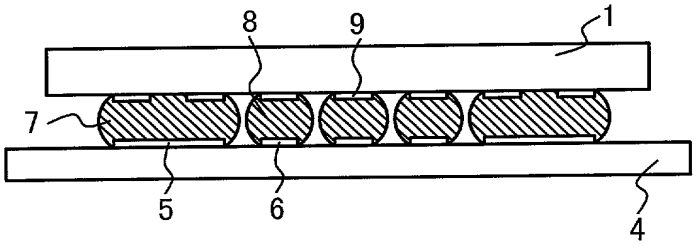


Fig. 6

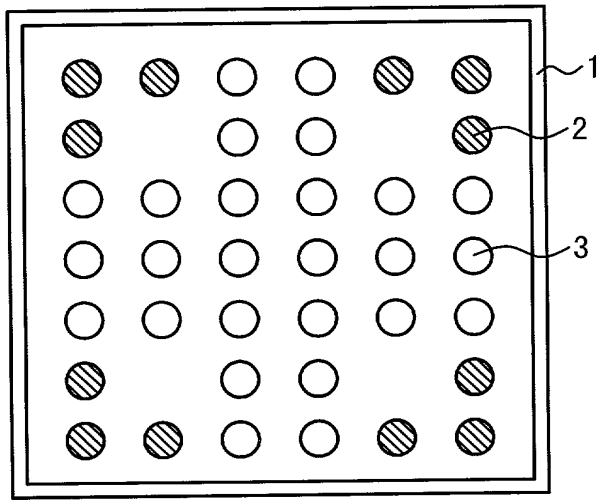
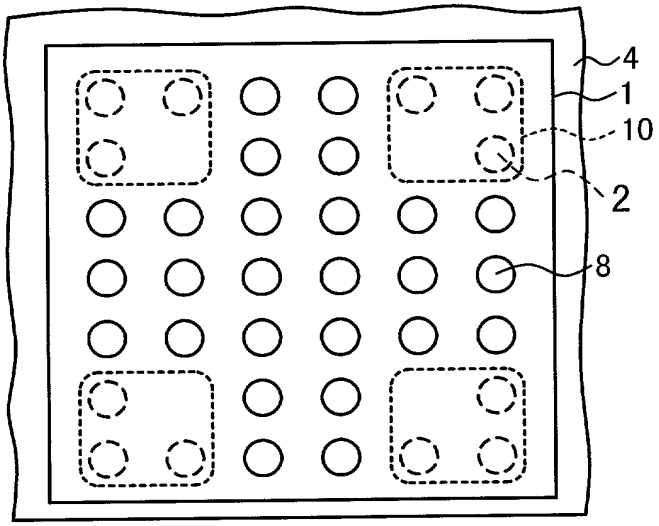


Fig. 7



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DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name: that I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought in the application entitled:

BACK ELECTRODE TYPE ELECTRONIC PART AND ELECTRONIC ASSEMBLY WITH THE SAME MOUNTED ON PRINTED CIRCUIT BOARD

which application is:
☒ the attached application *(for original application)*

☐ application Serial No. _____, filed _____, and amended on _____ *(for declaration not accompanying application)*

that I have reviewed and understand the contents of the specification of the above-identified application, including the claims, as amended by any amendment referred to above; that I acknowledge my duty to disclose information of which I am aware and which is material to the examination of this application under 37 C.F.R. 1.56(a); and that I hereby claim foreign priority benefits under Title 35, United States Code §119, §172 or §365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified on said list any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application on which priority is claimed:

Application Number	Country	Filing Date	Priority Claimed *(yes or no)*
346025/1998	Japan	December 4, 1998	yes

I hereby claim the benefit of Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge my duty to disclose any material information under 37 C.F.R. 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status *(patented, pending, abandoned)*

I hereby appoint John H. Mion, Reg. No. 18,879; Donald E. Zinn, Reg. No. 19,046; Thomas J. Macpeak, Reg. No. 19,292; Robert J. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Robert G. McMorrow, Reg. No. 19,093; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 26,577; Sheldon I. Landsman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; and Mark Boland, Reg. No. 32,197, my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to SUGHRUE, MION, ZINN, MACPEAK & SEAS, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date November 10, 1999

First Inventor YASUYOSHI (First Name) — Middle Initial — YAMADA (Last Name)

Residence Saitama, Japan

Signature Yasuyoshi Yamada

Post Office Address c/o NEC Saitama, Ltd., 300-18, Aza Toyohara, Oaza Motohara, Kamikawamachi, Kodama-gun, Saitama, Japan

Citizenship Japanese

Date _____

Second Inventor _____ (First Name) — (Middle Initial) — (Last Name)

Residence _____

Signature _____

Post Office Address _____

Citizenship _____